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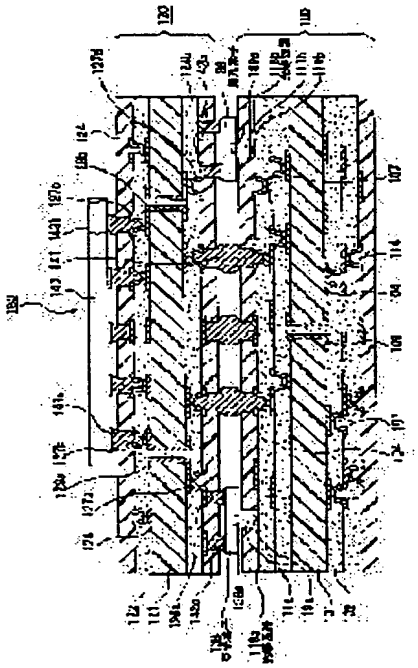
(54) DEVICE FOR OPTICAL COMMUNICATION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a device for optical communication which is composed of a board for IC chip mounting, where a light-receiving element and a light- emitting element are mounted in specified positions and a multilayer printed wiring board, where an optical waveguide path is formed at a specified position, and is low in connection loss between mounted optical parts, and is superior in reliability on connection.
SOLUTION: In this device for optical communication, consisting of the board 120 for IC mounting and the multilayer printed wiring board 100, the board 120 for IC chip-mounting includes a conductor circuit 129, an interlayer insulating layer 122, and a via hole 127 connecting the conductor circuits catching the interlayer insulating layer, and a light-receiving element 138 and a light- emitting element 139 are mounted on the board 120 for IC chip mounting.



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CLAIMS

[Claim(s)]
[Claim 1] the device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — said substrate for IC chip mounting — a conductor — the conductor the circuit, the layer insulation layer, and said whose layer insulation layer were pinched — the device for optical communication which is constituted including the Bahia hall which connects between circuits, and is characterized by mounting the photo detector and the light emitting device in said substrate for IC chip mounting.
[Claim 2] The device for optical communication according to claim 1 with which said photo detector and said light emitting device are mounted in said multilayer printed wiring board and the near field where it counters.
[Claim 3] The device for optical communication according to claim 1 with which said photo detector and said light emitting device are mounted in said multilayer printed wiring board, the field of the side which counters, and the field of the opposite side.
[Claim 4] The device for optical communication according to claim 1 with which either said photo detector or said light emitting devices are mounted in said multilayer printed wiring board and the near field where it counters, and another side is mounted in said multilayer printed wiring board, the field of the side which counters, and the field of the opposite side.
[Claim 5] The device for optical communication according to claim 3 or 4 with which the optical path for lightwave signal transmission which penetrates said substrate for IC chip mounting is formed.
[Claim 6] said conductor — the device for optical communication given in any 1 of claims 1-5 by which laminating formation of a circuit and said layer insulation layer is carried out one by one at both sides or one side of a substrate.
[Claim 7] The device for optical communication given in any 1 of claims 1-6 by which optical waveguide is formed in said multilayer printed wiring board.
[Claim 8] The device for optical communication according to claim 7 with which the optical path for lightwave signal transmission for transmitting a lightwave signal to said multilayer printed wiring board between said photo detector and said light emitting device, and said optical waveguide is formed.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the device for optical communication.
[0002] In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed. In the communication system using the optical fiber which has the descriptions, such as ** low loss, ** high bandwidth, ** narrow diameter and a light weight, no ** guiding, and ** saving resources, and has this description, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced substantially, construction and maintenance become easy, and an optical fiber can attain economization of communication system, and high-reliability-ization.
[0003] Moreover, since an optical fiber can multiplex simultaneously the light of the wavelength from which not only the light of one wavelength but many differ with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004] Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed. Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., it is necessary to attach the device for optical communication in a terminal equipment, and what was equipped with optics which process the optical waveguide which transmits a lightwave signal to a substrate, and a lightwave signal, such as a photo detector and a light emitting device, as a device for optical communication is proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, the conventional device for optical communication was not enough satisfactory in respect of connection dependability. This is considered to be because for the low connection loss in the factor for attaining the optical communication which is excellent in connection dependability, i.e., the connection between optics, (for example, connection with connection between an optical fiber and optical waveguide, optical waveguide and a photo detector, or a light emitting device) to fully have not been securable.
[0006] With the conventional device for optical communication, the area which mounts optical elements, such as a photo detector and a light emitting device, was beforehand formed in the substrate, and after attaching an optical element in this substrate, specifically, the optical element was mounted by filling up with and hardening embedding resin etc. However, when it is easy to generate location gap under the effect of the stress resulting from the curvature of the heat and substrate which receive this optical element in the cases, such as hardening processing of a layer insulation layer or a solder resist layer, and reflow processing of soldering paste, or the splash at the time of plating processing etc. when an optical element is mounted by such approach, and location gap is generated, connection dependability with other optics (optical waveguide and optical fiber) will fall. Furthermore, when mounting (cling) of an optical element was performed using adhesives or solder, by the heat history of an after process, this adhesives and solder might become soft and location gap of an optical element might occur in connection with this.
[0007]
[Means for Solving the Problem] Then, in order to secure low connection loss in connection between optics, as a result of inquiring wholeheartedly, in case this invention persons mounted an optic on a substrate and/or in a substrate, they hit on an idea for each optic to be mounted in a position, namely, for low connection loss to be secured by losing location gap of each optic, and completed the device for optical communication of this

invention which consists of the following configuration.
[0008] namely, the device for optical communication with which the device for optical communication of this invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — the above-mentioned substrate for IC chip mounting — a conductor — the conductor the circuit, the layer-insulation layer, and whose above-mentioned layer-insulation layer were pinched — it is constituted including the Bahia hall which connects between circuits, and it is characterized by to be mounted the photo detector and the light emitting device in the above-mentioned substrate for IC chip mounting.
[0009] In the device for optical communication of this invention, it is desirable to mount the above-mentioned photo detector and the above-mentioned light emitting device in the above-mentioned multilayer printed wiring board and the near field where it counters.
[0010] Moreover, in the above-mentioned device for optical communication, it is also desirable to mount the above-mentioned photo detector and the above-mentioned light emitting device in the above-mentioned multilayer printed wiring board, the field of the side which counters, and the field of an opposite hand, or to mount either the above-mentioned photo detector or the above-mentioned light emitting devices in the above-mentioned multilayer printed wiring board and the near field where it counters, and to mount another side in the above-mentioned multilayer printed wiring board, the field of the side which counters, and the field of an opposite hand. Furthermore, it is desirable to form the optical path for lightwave signal transmission which penetrates the above-mentioned substrate for IC chip mounting in this case.
[0011] moreover, the above-mentioned multilayer printed wiring board — setting — the above — a conductor — as for a circuit and the above-mentioned layer insulation layer, it is desirable to carry out laminating formation one by one at both sides or one side of a substrate.
[0012] Moreover, in the device for optical communication of this invention, it is desirable to form optical waveguide in the above-mentioned multilayer printed wiring board, and it is desirable to form the optical path for lightwave signal transmission for transmitting a lightwave signal to the above-mentioned multilayer printed wiring board in this case between the above-mentioned photo detector and the above-mentioned light emitting device, and the above-mentioned optical waveguide.
[0013]
[Embodiment of the Invention] Hereafter, the device for optical communication of this invention is explained. the device for optical communication with which the device for optical communication of this invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — the above-mentioned substrate for IC chip mounting — a conductor — the conductor the circuit, the layer-insulation layer, and whose above-mentioned layer-insulation layer were pinched — it is constituted including the Bahia hall which connects between circuits, and it is characterized by to be mounted the photo detector and the light emitting device in the above-mentioned substrate for IC chip mounting.
[0014] Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
[0015] the case where the photo detector and the light emitting device are especially mounted in the front face of the substrate for IC chip mounting — a conductor — the conductor the circuit, the layer insulation layer, and this whose layer insulation layer were pinched — in order for what is necessary to be just to perform mounting of a photo detector or a light emitting device at the last after forming the Bahia hall which connects a circuit — after mounting and a conductor — the heat or stress at the time of forming a circuit and a layer insulation layer are not received Therefore, the location gap resulting from such heat or stress does not occur, and a light emitting device and a photo detector can certainly be mounted in a desired location. Furthermore, when optical elements, such as a light emitting device and a photo detector, are mounted in the front face of the substrate for IC chip mounting, it is desirable that it is the thing of this flip chip mold. While being hard to generate location gap of optical elements, such as a light emitting device and a photo detector, etc., it is because RIPEA of an optical element can be performed easily.
[0016] Moreover, in the device for optical communication of this invention, when coming to connect the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board through a solder bump, both can be more certainly stationed to a position according to the self-alignment operation which solder has. In addition, in order that, as for a self-alignment operation, a solder resist layer may crawl solder, solder says the operation to which it is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity which self has at the time of reflow processing. Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected on the above-mentioned multilayer printed wiring board through the above-mentioned solder bump when this

self-alignment operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on the above-mentioned multilayer printed wiring board. therefore, if it is alike, respectively and optics, such as a photo detector, a light emitting device, and optical waveguide, are attached in the exact location, the device for optical communication which is excellent in connection dependability can be manufactured by [of the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board] connecting the above-mentioned substrate for IC chip mounting on the above-mentioned multilayer printed wiring board through a solder bump. Moreover, the same effectiveness can be acquired even when connecting both through BGA or PGA.

[0017] The photo detector and the light emitting device are mounted in the substrate for IC chip mounting which constitutes the above-mentioned device for optical communication. Here, although especially the mounting position of a photo detector and a light emitting device is not limited, it is desirable that it is the front face of the substrate for IC chip mounting as mentioned above. In that case, moreover, both photo detector and light emitting device It may be mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and It may be mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and the field of an opposite hand, and It may be mounted in the near field where either the above-mentioned photo detector or the light emitting devices oppose the multilayer printed wiring board of the substrate for IC chip mounting, and another side may be mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and the field of an opposite hand. In addition, when the photo detector and the light emitting device are mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and the field of an opposite hand, the above-mentioned photo detector and a light emitting device, and IC chip will usually be mounted in the front face by the side of the same of the substrate for IC chip mounting.

[0018] Thus, while the degree of freedom of a design of the device for optical communication improves more by choosing suitably the mounting position of the above-mentioned photo detector and a light emitting device according to the design of the device for optical communication, it will be harder coming to generate the location gap between the above-mentioned photo detector and a light emitting device, and the optical waveguide formed in the above-mentioned multilayer printed wiring board, and the connection dependability of a lightwave signal will improve more. Moreover, according to the design of the device for optical communication, it is hard coming to generate stress in the substrate for IC chip mounting by determining the mounting position of a photo detector and a light emitting device. the photo detector which specifically constitutes the substrate for IC chip mounting, a light emitting device, IC chip, a substrate, a layer insulation layer, and a conductor — generating of the stress resulting from the difference of the coefficient of thermal expansion of a circuit etc. can be suppressed by choosing each mounting position or a formation location suitably. Moreover, the reinforcement of the substrate for IC chip mounting is also securable.

[0019] Moreover, when the above-mentioned photo detector and the light emitting device are mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and the field of an opposite hand, And it is mounted in the near field where either the above-mentioned photo detector or the light emitting devices oppose the multilayer printed wiring board of the substrate for IC chip mounting. When another side is mounted in the field of the side which opposes the multilayer printed wiring board of the substrate for IC chip mounting, and the field of an opposite hand, it is desirable to form the optical path for lightwave signal transmission which penetrates the above-mentioned substrate for IC chip mounting. It is because a lightwave signal can be transmitted between the optical waveguides formed in the multilayer printed wiring board through this optical path for lightwave signal transmission. Moreover, by choosing suitably whether the mounting position of a photo detector and a light emitting device and the optical path for lightwave signal transmission are formed, the mounting position of a photo detector and a light emitting device can be chosen more freely, consequently a free space becomes large in the design of the substrate for IC chip mounting, and high density wiring etc. can be attained. in addition, the above-mentioned free space — a conductor — the field which forms a circuit or mounts electronic parts, such as a capacitor, is said.

[0020] As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned device for optical communication, demand characteristics, etc. Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector. In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.

[0021] As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned device for optical communication.

[0022] As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned. That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.

[0023] Moreover, although the above-mentioned photo detector and the above-mentioned light emitting device may be the things of a wirebonding mold, it is desirable that it is the thing of a flip chip mold. It is because RIPEA is easy when location gap surface-mount-makes the photo detector and light emitting device of a flip chip mold hard to generate according to a self-alignment operation at the time of mounting.

[0024] Moreover, when the optical path for lightwave signal transmission is formed in the above-mentioned substrate for IC chip mounting, although the interior of this optical path for lightwave signal transmission may be an opening, the conductor layer may be formed in the wall surface of this optical path for lightwave signal transmission, and the resin layer for optical paths may be formed in the interior of this optical path for lightwave signal transmission. In addition, the above-mentioned conductor layer and the above-mentioned resin layer for optical paths may be formed in a part of optical path for lightwave signal transmission, respectively. When the conductor layer is formed in the wall surface of the above-mentioned optical path for lightwave signal transmission, as for this conductor layer, being formed with the metal which has gloss is desirable, and nickel, Au, Ag, etc. are mentioned as a metaled example of having the above-mentioned gloss, for example. Moreover, although it is not limited especially as construction material of this resin layer for optical paths when the resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, it is desirable for the permeability of the communication link wavelength light to be 70% or more.

[0025] In addition, the permeability of the communication link wavelength light of the above-mentioned resin layer for optical paths means the permeability of the communication link wavelength light per die length of 1mm. When the light of I1 carried out incidence to the above-mentioned resin layer for optical paths in strength, passing this resin layer for optical paths 1mm, and having come out, and the intensity of light which came out is I2, it is specifically the value computed by the following formula (1).

[0026]

Permeability (%) =(I2/I1) x100 ... (1)

[0027] moreover, the above-mentioned substrate for IC chip mounting — both sides or one side of a substrate -- a conductor — it is desirable to carry out laminating formation of a circuit and the layer insulation layer one by one. both sides or one side of a substrate which a core specifically becomes from the resin substrate by which impregnation was carried out — a conductor — the conductor whose above-mentioned layer insulation layer the circuit and the layer insulation layer are formed by the build up method, and was pinched further — it is desirable to form the Bahia hall which connects a circuit. A photo detector and a light emitting device, and also when IC chip is mounted, it is further hard to generate curvature and stress in the substrate for IC chip mounting, and it is hard to generate location gap of the photo detector resulting from these, a light emitting device, etc. by considering as such a configuration. moreover, the build up method — a conductor — by forming a circuit, a layer insulation layer, and the Bahia hall, wiring of the substrate for IC chip mounting can be carried out to detailed wiring, and densification of the substrate for IC chip mounting can be attained. Furthermore, between IC chips is electrically connectable with a photo detector and a light emitting device certainly.

[0028] Moreover, as for the above-mentioned substrate for IC chip mounting, it is desirable to form the solder bump for transmitting an electrical signal. Thereby, it is because an electrical signal can be transmitted between external electronic parts.

[0029] Moreover, optical waveguide is formed in the multilayer printed wiring board which constitutes the above-mentioned device for optical communication, and a lightwave signal can be transmitted to it through this optical waveguide. Moreover, in the above-mentioned multilayer printed wiring board, it is desirable to form the optical path for lightwave signal transmission for transmitting a lightwave signal between the above-mentioned photo detector and a light emitting device, and the above-mentioned optical waveguide. It is because a lightwave signal can be transmitted between the photo detectors and light emitting devices which were formed in the substrate for IC chip mounting through this optical path for lightwave signal transmission.

[0030] Moreover, by forming suitably the above-mentioned optical path for lightwave signal transmission in the above-mentioned multilayer printed wiring board, the degree of freedom of a design of a multilayer printed wiring board will improve more, and, thereby, can attain the densification of a multilayer printed wiring board, as a result the densification of the device for optical communication. This is because a dead space is made by the **** thing to do in a multilayer printed wiring board by choosing the formation location of optical waveguide freely

according to the design of a multilayer printed wiring board. the above-mentioned dead space — a conductor — the thing of the field where formation of a circuit and mounting of electronic parts, such as a capacitor, are restricted is said. since [usually,] optical waveguide is formed so that the whole surface or a part of substrate and layer insulation layer may be crossed — the neighboring field of optical waveguide — a conductor — formation of a circuit etc. will be restricted.

[0031] As an ingredient of the above-mentioned optical waveguide, quartz glass, a compound semiconductor, a polymer ingredient, etc. are mentioned, for example. In these, while excelling in workability, it excels in adhesion with the layer insulation layer of a multilayer printed wiring board, and the point which is low cost to a polymer is desirable.

[0032] As the above-mentioned polymer ingredient, a well-known thing can be used conventionally, and, specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.

[0033] Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-50 micrometers, and the width of face has desirable 1-50 micrometers. In the above-mentioned multilayer printed wiring board, it is desirable for the optical waveguide formed in the location which counters the photo detector of the substrate for IC chip mounting, and the optical waveguide formed in the location which counters the light emitting device of the substrate for IC chip mounting to be what consists of the same ingredient. Moreover, it is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle. Formation of the above-mentioned optical-path conversion mirror can be performed by carrying out grinding of the end of optical waveguide so that it may mention later. Moreover, as for the above-mentioned multilayer printed wiring board, it is desirable to form the solder bump for transmitting an electrical signal. Thereby, it is because an electrical signal can be transmitted between external electronic parts.

[0034] Specifically, both can be stationed by connecting through a solder bump to the position which the above-mentioned photo detector and the above-mentioned light emitting device, and the above-mentioned optical waveguide counter. It is because a self-alignment operation of solder can be used. In addition, the same effectiveness can be acquired also when the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board are connected through PGA or BGA.

[0035] As mentioned above, as explained, it consists of devices for optical communication of this invention so that a lightwave signal can be transmitted between the photo detector and light emitting device which were mounted in the substrate for IC chip mounting, and the optical waveguide formed in the multilayer printed wiring board, and the optical path for lightwave signal transmission is suitably formed in the above-mentioned substrate for IC chip mounting, and/or the multilayer printed wiring board if needed. Moreover, with the device for optical communication of this invention which consists of a configuration mentioned above, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.

[0036] The operation gestalt of the device for optical communication which consists of the above-mentioned configuration hereafter is explained referring to a drawing. Drawing 1 is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 1 .

[0037] As shown in drawing 1 , the device 150 for optical communication of this invention consists of the substrates 120 for IC chip mounting and multilayer printed wiring boards 100 which mounted the IC chip 140, and the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 are electrically connected through the solder connection 141.

[0038] the mounting substrate 120 for IC chip — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the layer insulation layer [a circuit 124 (124a, 124b) and] 122 was pinched — circuits and the conductor whose layer insulation layer 122 was pinched — circuits are electrically connected by the through hole 129 (129a, 129b) and the Bahia hall 127 (127a, 127b, 127c, 127d), respectively. Moreover, the solder resist layer 134 equipped with the solder bump is formed in the outermost layer of drum of the mounting substrate 120 for IC chip, in addition the outermost layer of drum of a multilayer printed wiring board 100 and the side which counters is equipped with the photo detector 138 and the light emitting device 139 so that light sensing portion 138a and light-emitting part 139a may be exposed, respectively.

[0039] a multilayer printed wiring board 100 — both sides of a substrate 101 — a conductor — the conductor with which laminating formation was carried out and the substrate 101 of the layer insulation layer [a circuit 104

and] 102 was pinched — circuits and the conductor whose layer insulation layer 102 was pinched — circuits are electrically connected by the through hole 109 and the Bahia hall 107, respectively. Moreover, while the solder resist layer 114 equipped with the opening 111 for optical paths and a solder bump is formed in the mounting substrate 120 for IC chip of a multilayer printed wiring board 100, and the outermost layer of drum of the side which counters, the optical waveguide 118 (118a, 118b) equipped with the optical conversion mirror 119 (119a, 119b) is formed directly under [for optical paths] opening 111 (111a, 111b).

[0040] In the device 150 for optical communication which consists of such a configuration The lightwave signal sent from the outside through an optical fiber (not shown) is introduced into optical waveguide 118a. After being sent to the photo detector 138 (light sensing portion 138a) through optical-path conversion mirror 119a and opening 111a for optical paths, it changes into an electrical signal by the photo detector 138 — having — further — conductive layer 142a- a conductor — it will be sent to the IC chip 140 through circuit 124a-Bahia hall 127a-through hole 129a-Bahia hall 127b-solder connection 143a.

[0041] Moreover, the electrical signal sent out from the IC chip 140 solder connection 143b-Bahia hall 127c-through hole 129b-Bahia hall 127d- a conductor, after being sent to a light emitting device 139 through circuit 124b-conductive layer 142b it changes into a lightwave signal by the light emitting device 139 — having — this lightwave signal — opening from light emitting device 139 (light-emitting part 139a) 111for optical paths b — and it conversion mirror [optical] 119b minds, is introduced into optical waveguide 118b, and is delivery outside as a lightwave signal through an optical fiber (not shown) further — it will be carried out.

[0042] In the device for optical communication of this invention, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder bump — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). In the device 150 for optical communication of this invention as shown in drawing 1 , a photo detector and a light emitting device will be mounted in a multilayer printed wiring board and the field of the side which counters.

[0043] The operation gestalt of the device for optical communication of this invention may be a gestalt as not limited to the gestalt shown in drawing 1 and shown in drawing 2 R>2-6. Drawing 2 -6 are the sectional view showing typically a different example of the device for optical communication of this invention, respectively. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 2 -6. moreover, the operation gestalt of the device for optical communication which showed the configuration of each device for optical communication shown in drawing 2 R>2-6 fundamentally to drawing 1 and abbreviation — since it is the same, suppose that only a different point from the device 150 for optical communication shown in drawing 1 is explained here.

[0044] The optical path 251 for lightwave signal transmission which penetrates this is formed, conductor-layer 251b is formed in a part of that wall surface, and, as for this optical path 251 for lightwave signal transmission, resin 251a for optical paths is further filled up into the substrate 220 for IC chip mounting with the device 250 for optical communication shown in drawing 2 in a part of that interior. Moreover, a photo detector 238 and a light emitting device 239 are mounted in the near field where the IC chip 240 was mounted, and through the optical path 251 for lightwave signal transmission, it consists of substrates 220 for IC chip mounting so that a lightwave signal can be transmitted between a photo detector 238, a light emitting device 239, and optical waveguide 219 (219a, 219b). In this device 250 for optical communication, the photo detector 238 and the light emitting device 239 are mounted in the field of the same side as the field which mounted the IC chip 240 of the substrate 220 for IC chip mounting, and a photo detector 238, a light emitting device 239, and optical waveguide 219 can transmit a lightwave signal through the optical path 251 for lightwave signal transmission.

[0045] The optical path 361 for lightwave signal transmission which penetrates a substrate 301, the layer insulation layer 302, and the solder resist layer 314 is formed in the multilayer printed wiring board 300, and through this optical path 361 for lightwave signal transmission, it consists of devices 350 for optical communication shown in drawing 3 so that a lightwave signal can be transmitted between optical waveguide 319 (319a, 319b), and a photo detector 338 and a light emitting device 339. Furthermore, conductor-layer 361b is formed in a part of that wall surface, and, as for this optical path 361 for lightwave signal transmission, a part of that interior is filled up with resin 361a for optical paths. Moreover, in the multilayer printed wiring board 300, the formation location of optical waveguide 319 differs from the multilayer printed wiring board 100 shown in drawing 1 , and is formed on both sides of the substrate 301 on the substrate 320 for IC chip mounting, and the layer nsulation layer 302 of the outermost layer of drum of an opposite hand. In this device 350 for optical

communication, a photo detector 338, a light emitting device 339, and optical waveguide 319 can transmit a lightwave signal through the optical path 361 for lightwave signal transmission which penetrates the substrate 301 and the layer insulation layer 302 which were formed in the multilayer printed wiring board 300, and the solder resist layer 314.

[0046] The optical path 451 for lightwave signal transmission which penetrates this is formed in the substrate 420 for IC chip mounting, conductor-layer 451b is formed in a part of that wall surface, and, as for this optical path 451 for lightwave signal transmission, resin 451a for optical paths is further filled up into a part of that interior with the device 450 for optical communication shown in drawing 4 . The configuration of this substrate 420 for IC chip mounting is the same as the configuration of the substrate 220 for IC chip mounting shown in drawing 2 .

[0047] Moreover, the optical path 461 for lightwave signal transmission which penetrates a substrate 401, the layer insulation layer 402, and the solder resist layer 414 is formed in the multilayer printed wiring board 400, and through this optical path 461 for lightwave signal transmission, it is constituted so that a lightwave signal can be transmitted between optical waveguide 419, and a photo detector 438 and a light emitting device 439. The configuration of this multilayer printed wiring board 400 is the same as the configuration of the multilayer printed wiring board 300 shown in drawing 3 . In this device 450 for optical communication, a photo detector 438, a light emitting device 439, and optical waveguide 419 can transmit a lightwave signal through the optical path 461 for lightwave signal transmission which penetrates the optical path 451 for lightwave signal transmission which was formed in the substrate 420 for IC chip mounting, and which penetrates this, and the substrate 401 and the layer insulation layer 402 which were formed in the multilayer printed wiring board 400, and the solder resist layer 414.

[0048] Moreover, in the substrate for IC chip mounting shown in drawing 5 , the photo detector 538 is mounted in the multilayer printed wiring board 500 of the substrate 520 for IC chip mounting, and the field of the side which counters, and the light emitting device 539 is mounted in the multilayer printed wiring board 500, the field of the side which counters, and the field of an opposite hand. Moreover, the optical path 551 for lightwave signal transmission which penetrates the substrate 520 for IC chip mounting is formed so that a lightwave signal can be transmitted between the optical waveguides by which the light emitting device 539 was formed in the multilayer printed wiring board 500. Conductor-layer 551b is formed in a part of the wall surface, and, as for the optical path 551 for lightwave signal transmission, resin layer 551a for optical paths is formed in a part of the interior.

[0049] Moreover, optical waveguide is formed in the multilayer printed wiring board 500. Optical waveguide 518a for transmitting a lightwave signal between photo detectors 538 Optical waveguide 518b for being formed on both sides of the substrate 501 on the layer insulation layer 502 of the outermost layer of drum of the side near the substrate 520 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 539 On both sides of the substrate 501, it is formed on the substrate 520 for IC chip mounting, and the layer insulation layer 502 of the outermost layer of drum of an opposite hand. Furthermore, the optical path 561 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 539 and optical waveguide 618b is formed in the multilayer printed wiring board 500. The optical path 561 for lightwave signal transmission is formed so that a substrate 501, the layer insulation layer 502, and the solder resist layer 514 may be penetrated, conductor-layer 561b is formed in a part of the wall surface, and resin layer 561a for optical paths is formed in a part of the interior.

[0050] In this device 550 for optical communication, a light emitting device 539 and optical waveguide 519b can transmit a lightwave signal through the optical path 561 for lightwave signal transmission which penetrates the optical path 551 for lightwave signal transmission which was formed in the substrate 520 for IC chip mounting, and which penetrates this, and the substrate 501 and the layer insulation layer 502 which were formed in the multilayer printed wiring board 500, and the solder resist layer 514. In addition, a photo detector 538 and optical waveguide 519a can transmit a lightwave signal through opening 511a for optical paths formed in the solder resist layer of a multilayer printed wiring board 500.

[0051] Moreover, in the device 650 for optical communication shown in drawing 6 , the photo detector 638 is mounted in the multilayer printed wiring board 600 of the substrate 620 for IC chip mounting, the field of the side which counters, and the field of an opposite hand, and the light emitting device 639 is mounted in the multilayer printed wiring board 600 and the near field where it counters. Moreover, the optical path 651 for lightwave signal transmission which penetrates the substrate 620 for IC chip mounting is formed so that a lightwave signal can be transmitted between optical waveguide 618a by which the photo detector 638 was formed in the multilayer printed wiring board 600. Conductor-layer 651a is formed in a part of that wall surface, and, as for this optical path 651 for lightwave signal transmission, the resin layer for optical paths is formed in a part of that interior.

[0052] Moreover, optical waveguide 618a for optical waveguide 619 being formed in the multilayer printed wiring

board 600, and transmitting a lightwave signal to it between photo detectors 638 Optical waveguide 618b for being formed on both sides of the substrate 601 on the layer insulation layer of the outermost layer of drum of the side near the substrate 620 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 639 On both sides of the substrate 601, it is formed on the substrate 620 for IC chip mounting, and the layer insulation layer of the outermost layer of drum of an opposite hand. Furthermore, the optical path 651 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 639 and optical waveguide 618b is formed in the multilayer printed wiring board 600. The optical path 661 for lightwave signal transmission is formed so that a substrate 601, the layer insulation layer 602, and the solder resist layer 614 may be penetrated, conductor-layer 661b is formed in a part of the wall surface, and resin layer 661a for optical paths is formed in a part of the interior.

[0053] In this device 650 for optical communication, a light emitting device 639 and optical waveguide 619b can transmit a lightwave signal through the optical path 661 for lightwave signal transmission which penetrates the substrate 601 and the layer insulation layer 602 which were formed in the multilayer printed wiring board 600, and the solder resist layer 614. Moreover, a photo detector 638 and optical waveguide 619a can transmit a lightwave signal through the optical path 651 for lightwave signal transmission which was formed in the substrate 620 for IC chip mounting and which penetrates this. What is necessary is just to form these conductor layers and the resin layer for optical paths if needed, although a conductor layer is formed in the wall surface and, as for the optical path for lightwave signal transmission formed in the device for optical communication shown in drawing 1 -6, the resin layer for optical paths is formed in the interior.

[0054] In addition, as mentioned above, the operation gestalt of the substrate for IC chip mounting of this invention should just be a gestalt which chose suitably whether it would not necessarily be limited to the gestalt shown in drawing 1 -6, and the mounting position of a photo detector or a light emitting device, the formation location of optical waveguide, and the optical path for lightwave signal transmission would be formed, and combined it. Moreover, although IC chip mounted in the device for optical communication of such this invention may be mounted by wirebonding and mounted by flip chip bonding, it is desirable that it is what is mounted by flip chip bonding.

[0055] Next, how to manufacture the device for optical communication of this invention is explained. the photo detector of the substrate for IC chip mounting after the above-mentioned device for optical communication manufactures independently for example, the substrate for IC chip mounting, and a multilayer printed wiring board and a light emitting device, and the conductor of a multilayer printed wiring board — both are stationed so that a circuit may counter, and further, solder bumps are connected by reflow processing, adjusting both location, and it manufactures by forming a solder connection. Therefore, suppose that the manufacture approach of the substrate for IC chip mounting and the manufacture approach of a multilayer printed wiring board are explained independently, and how to connect both is explained after that first here.

[0056] First, the manufacture approach of the substrate for IC chip mounting is explained. In addition, as mentioned above, since being formed using the build up method is desirable as for the above-mentioned substrate for IC chip mounting, suppose that it is explained centering on the substrate for IC chip mounting by the build up method here.

[0057] (1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit. As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine (BT) resin substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example. Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used. the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.

[0058] moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a breakthrough, the through hole is formed by performing nonelectrolytic plating processing etc. In addition, the diameter of the above-mentioned breakthrough is usually 100-300 micrometers. Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.

[0059] Moreover, at this process, while forming the breakthrough for through holes if needed, the breakthrough (henceforth the breakthrough for optical paths) for forming the optical path for lightwave signal transmission may be formed. Moreover, a conductor layer may be formed in the wall surface of the above-mentioned breakthrough for optical paths if needed. As for the above-mentioned conductor layer, forming using nickel, Au, Ag, etc. is

specifically [forming using the metal which has gloss is desirable and] desirable. Furthermore, it may be filled up with the resin constituent for forming the resin layer for optical paths in the above-mentioned breakthrough for optical paths. In addition, restoration of a resin constituent is an after process, and after forming the layer insulation layer which has a breakthrough for optical paths, and opening which was open for free passage, it may be performed.

[0060] (2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit. as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned. the case where a roughening side is formed here —.the average relative roughness of this roughening side — usually — 0.1-5 micrometers — desirable — a conductor — the adhesion of a circuit and a layer insulation layer, and a conductor — when the effect to the electrical signal transmission ability of a circuit etc. is taken into consideration, 2-4 micrometers is more desirable. In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.

[0061] (3) next, a conductor — form the resin layer which forms the resin layer which is not hardened [which some of thermosetting resin photopolymers, and thermosetting resin become from the acrylic-ized resin, these and thermoplastics, and the included resin complex] on the substrate in which the circuit was formed, or consists of thermoplastics. The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening). Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated on the film.

[0062] In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc. Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.

[0063] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example. As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.

[0064] As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example. Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic—ization-react as resin which acrylic-ized some above-mentioned thermosetting resin for example, is mentioned.

[0065] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.

[0066] Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin which acrylic-ized some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, the epoxy resin that acrylic-ized a part of epoxy group, polyether sulfone, etc. are mentioned, for example.

[0067] Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.

[0068] Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer. It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc. While securing the outstanding adhesion with an insulating substrate by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls

etc. at an after process is securable. moreover, instead of [of the above-mentioned resin layer] — a core — the layer which consists of a base material of entering, a resin base material containing GARAEPO, etc. may be formed.

[0069] Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation. The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer. In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.

[0070] In case the above-mentioned roughening liquid is used for a layer insulation layer and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, by using a photopolymer, exposure and a development may be used for a layer insulation layer, and opening for the Bahia halls may be formed.

[0071] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)—ization-react using a methacrylic acid, an acrylic acid, etc.

[0072] As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.

[0073] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

[0074] It is desirable that it is at least one sort as which the matter of fusibility is chosen from an inorganic particle, a resin particle, and metal particles to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer.

[0075] As the above-mentioned inorganic particle, an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

[0076] As the above-mentioned aluminium compound, as the above-mentioned lime compound, a calcium carbonate, a calcium hydroxide, etc. are mentioned, potassium carbonate etc. is mentioned, an alumina, an aluminum hydroxide, etc. are mentioned and a silica, a zeolite, etc. are mentioned [a magnesia, a dolomite basic magnesium carbonate, talc, etc. are mentioned, and] as the above-mentioned silicon compound as the above-mentioned magnesium compound as the above-mentioned potassium compound, for example. These may be used independently and may be used together two or more sorts.

[0077] Dissolution clearance of the above-mentioned alumina particle can be carried out by fluoric acid, and dissolution clearance of the calcium carbonate can be carried out with a hydrochloric acid. Moreover, dissolution clearance of a sodium content silica or the dolomite can be carried out in an alkali water solution.

[0078] As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. are mentioned. These may be used independently and may be used together two or more sorts. In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle will dissolve in the solvent in which a resin matrix is dissolved if it is not made to harden.

[0079] Moreover, as the above-mentioned resin particle, a rubber particle, liquid phase resin, liquid phase rubber, etc. may be used. As the above-mentioned rubber particle, acrylonitrile-butadiene rubber, polychloroprene rubber, polyisoprene rubber, acrylic rubber, multi-** system rigidity rubber, a fluororubber, polyurethane rubber, silicone rubber, ABS plastics, etc. are mentioned, for example. Moreover, for example, various denaturation

polybutadiene rubbers, such as polybutadiene rubber, epoxy denaturation, urethane denaturation, and acrylonitrile (meta) denaturation, the acrylonitrile-butadiene rubber (meta) containing a carboxyl group, etc. may be used.

[0080] As the above-mentioned liquid phase resin, the non-hardened solution of the above-mentioned thermosetting resin can be used, and epoxy non-hardened oligomer, the mixed liquor of an amine system curing agent, etc. are mentioned as an example of such liquid phase resin, for example. As the above-mentioned liquid phase rubber, non-hardened solutions, such as various denaturation polybutadiene rubbers, such as the above-mentioned polybutadiene rubber, epoxy denaturation, urethane denaturation, and acrylonitrile (meta) denaturation, and acrylonitrile-butadiene rubber (meta) containing a carboxyl group, etc. can be used, for example.

[0081] To prepare the above-mentioned photopolymer constituent using the above-mentioned liquid phase resin or liquid phase rubber, a heat-resistant-resin matrix and the matter of fusibility need to dissolve and twist to homogeneity (that is, phase separation is carried out like), and need to choose these matter like. By mixing the heat-resistant-resin matrix chosen by the above-mentioned criteria and the matter of fusibility, the photopolymer constituent in the condition that the "island" of a heat-resistant-resin matrix is distributing in the "sea" of the condition which the "island" of liquid phase resin or liquid phase rubber is distributing in the "sea" of the above-mentioned heat-resistant-resin matrix, liquid phase resin, or liquid phase rubber can be prepared. And after stiffening the photopolymer constituent of such a condition, a roughening side can be formed by removing the liquid phase resin or liquid phase rubber of the "sea" or a an "island."

[0082] As the above-mentioned metal particles, gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.

[0083] When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the layer insulation layer which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of a layer insulation layer — a crack — not generating — a layer insulation layer and a conductor — it is because exfoliation does not occur between circuits.

[0084] It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. It is because it is hard to make the metallic conductor layer exposed from the Bahia hall corrode when roughening processing is carried out. As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example. Moreover, as the above-mentioned alkali, water solutions, such as a sodium hydroxide and a potassium hydroxide, are desirable.

[0085] The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less. Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.5 micrometers, and the matter of the fusibility whose mean particle diameter's is 1-2 micrometers etc.

[0086] Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed. Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable. Mean particle diameter exceeds 0.8 micrometers, and that of the above-mentioned coarse grain is less than 2.0 micrometers, and, as for a particle, it is desirable for mean particle diameter to be 0.1-0.8 micrometers.

[0087] (4) Next, in forming the layer insulation layer using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as a layer insulation layer. Moreover, at this process, a breakthrough (the breakthrough for through hole formation and breakthrough for the optical-path formation for lightwave signal transmission) may be formed if needed. As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of a layer insulation layer, you may form by the exposure development.

[0088] Moreover, in forming the layer insulation layer using thermoplastics as the ingredient, opening for the

Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as a layer insulation layer. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this breakthrough by drilling, the lasing, etc., when forming a breakthrough at this process. Moreover, when the breakthrough for optical paths is formed at the process of the above (1), it is desirable to form opening for optical paths which forms opening for the Bahia halls and which was [both] open for free passage to the above-mentioned breakthrough for optical paths here. This opening for optical paths also becomes a part of optical path for lightwave signal transmission through an after process.

[0089] As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.

[0090] Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed in a resin film layer efficiently by exposure by using this method.

[0091] Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds. Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts. Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.

[0092] (5) next, the front face of a layer insulation layer including the wall of opening for the Bahia halls — a conductor — form a circuit. a conductor — in forming a circuit, a thin film conductor layer is first formed in the front face of a layer insulation layer. The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.

[0093] As construction material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example. In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, profitability, etc. is desirable. Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.3-2.0 micrometers is desirable and 0.6-1.2 micrometers is more desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.

[0094] Moreover, before forming the above-mentioned thin film conductor layer, a roughening side may be formed in the front face of a layer insulation layer if needed. By forming a roughening side, the adhesion of a layer insulation layer and a thin film conductor layer can be raised. When a layer insulation layer is especially formed using the resin constituent for roughening side formation, it is desirable to form a roughening side using an acid, an oxidizer, etc.

[0095] Moreover, when the breakthrough for through hole formation is formed at the process of the above (4), in case a thin film conductor layer is formed on a layer insulation layer, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of this breakthrough. Moreover, when the breakthrough for optical paths is formed at the process of the above (4), it is desirable to form the conductor layer which consists of a metal which has gloss which may form a conductor layer also in the wall surface of this breakthrough for optical paths, and was mentioned above in that case.

[0096] (6) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face. After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.

[0097] (7) After that, electroplate by making a thin film conductor layer into a plating bar, and form a electroplating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electroplating, copper plating is desirable. Moreover, the thickness of the above-mentioned electroplating layer and 5-20 micrometers are desirable.

[0098] then, the thing for which the nonelectrolytic plating film and thin film conductor layer under the above-mentioned plating resist and this plating resist are removed — a conductor — a circuit (the Bahia hall is included) can be formed. What is necessary is just to perform clearance of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform clearance of the above-mentioned plating resist for example, using an alkali water solution etc. moreover, the above — a conductor — after forming a circuit, the catalyst on a layer insulation layer may be

removed using an acid or an oxidizer if needed. It is because lowering of an electrical property can be prevented. moreover, the method of performing etching processing, after replacing with the approach (a process (6) and (7)) of forming a electroplating layer after forming this plating resist and forming a electroplating layer the whole surface on a thin film conductor layer — using — a conductor — a circuit may be formed.

[0099] Moreover, when a through hole is formed in the above (4) and the process of (5), it may be filled up with a resin filler in this through hole. Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed. Moreover, when the breakthrough for optical paths is formed, the resin constituent for forming the resin layer for optical paths may be separately filled up with the process of the above (4) at this process.

[0100] (8) next, the thing for which roughening processing is performed on the front face of this lid plating layer, and the process of (3) - (7) is further repeated if needed when a lid plating layer is formed — the both sides — a layer insulation layer and a conductor — carry out laminating formation of the circuit. In addition, a through hole may be formed and it is not necessary to form at this process. Moreover, depending on the case, the breakthrough for optical paths may be formed at this process.
 [0101] (9) next, a conductor — form a solder resist layer in the outermost layer of drum of the substrate in which the circuit and the layer insulation layer were formed. The above-mentioned solder resist layer can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.

[0102] moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C.

[0103] (10) Next, form opening for solder bump formation, and opening for optical element mounting in the above-mentioned solder resist layer. Formation with the above-mentioned opening for solder bump formation and opening for optical element mounting can be performed using the approach of forming opening for the Bahia halls, and the same approach, i.e., an exposure development and the lasing. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical element mounting may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand. Moreover, when the breakthrough for optical paths is formed at the process mentioned above, this breakthrough for optical paths and opening which was open for free passage are formed in a solder resist layer. This opening also becomes a part of optical path for lightwave signal transmission. in addition, the conductor mentioned above depending on the case — after forming a circuit, a layer insulation layer, and a solder resist layer on a substrate, the breakthrough for optical paths which penetrates these may be formed at once.

[0104] (11) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, tin, palladium, gold, silver, and platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold. Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer. moreover, the conductor exposed by forming opening for optical element mounting at this process — it is desirable to form an enveloping layer also in a circuit part.

[0105] (12) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad.

[0106] (13) An optical element (a photo detector and light emitting device) is further mounted in a solder resist layer. What is necessary is for mounting of an optical element to fill up soldering paste with the process of the above (12) also into opening for optical element mounting, and just to mount it through solder (conductive layer) further, by attaching the above-mentioned optical element, in case a reflow is performed. Moreover, it may replace with soldering paste and an optical element may be mounted using electroconductive glue etc. When these approaches are used, a photo detector and a light emitting device will be mounted in the front face of a solder resist layer. Moreover, also when the optical path for lightwave signal transmission which penetrates the substrate for IC chip mounting is formed, a photo detector and a light emitting device mount in the front face of a solder resist layer and are desirable. The reason is as having mentioned above. Moreover, the flip chip type thing of the optical element (a photo detector and light emitting device) mounted at this process is desirable.

[0107] Moreover, it may replace with the above-mentioned approach of carrying out a surface mount, in case opening for optical element mounting is formed at the process of the above (10), opening may be formed in the magnitude which can contain an optical element, and you may mount by containing an optical element in opening through electroconductive glue after that. In this case, a photo detector and a light emitting device will be built in a solder resist layer. By passing through such a process, the substrate for IC chip mounting which constitutes the device for optical communication of this invention can be manufactured.

[0108] Next, the manufacture approach of a multilayer printed wiring board is explained.

(1) the first same process as (1) - (8) of the manufacture approach of the above-mentioned substrate for IC chip mounting -- carrying out -- the both sides -- a conductor -- a circuit and a layer insulation layer produce the substrate by which laminating formation was carried out repeatedly. In addition, the through hole is suitably formed also at this process. Moreover, at this process, the breakthrough for optical paths for forming the optical path for lightwave signal transmission is formed like the production process of the substrate for IC chip mounting if needed. In consideration of the design of multilayer printed wiring boards, such as a formation location of optical waveguide, it should just determine suitably whether the breakthrough for optical paths is formed. Moreover, when the above-mentioned breakthrough for optical paths is formed, the conductor layer which becomes the wall surface of this breakthrough for optical paths from the metal which has gloss may be formed. Moreover, it may be filled up with the resin constituent for forming the resin layer for optical paths in the interior of the breakthrough for optical paths.

[0109] (2) next, the conductor on the substrate for IC chip mounting, and the layer insulation layer of the side which counters -- form optical waveguide in the circuit agenesis section. Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient. Moreover, when the optical path which penetrates a substrate and a layer insulation layer at the process of the above (1) is formed, on both sides of a substrate, optical waveguide will be formed on the layer insulation layer of an opposite hand the substrate for IC chip mounting, and a side. In addition, the formation location of optical waveguide may not necessarily be limited on the layer insulation layer of an outermost layer of drum, and may be between layer insulation layers. Moreover, the optical waveguide which consists of the above-mentioned inorganic material can be formed by making the inorganic material of LiNbO3 and LiTaO3 grade form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.

[0110] Moreover, when forming the above-mentioned optical waveguide using a polymer ingredient, the film for optical waveguide formation fabricated in the shape of a film on the substrate or the mold releasing film can be beforehand stuck on a layer insulation layer, or optical waveguide can be formed from forming directly on a layer insulation layer. Specifically, it can form using a selective polymerization method, the approach using reactive ion etching and photolithography, the direct exposing method, the approach using injection molding, the photograph breeching method, the approach that combined these. In addition, these approaches can be used also when forming directly it forms on a layer insulation layer also when forming optical waveguide on a substrate or a mold releasing film.

[0111] Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide. Although you may form before attaching the above-mentioned optical-path conversion mirror on a layer insulation layer, and you may form after attaching on a layer insulation layer, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on a layer insulation layer. other members which can work easily and constitute a multilayer printed wiring board at the time of an activity, for example, a conductor, -- it is because a blemish is attached to a circuit, a layer insulation layer, etc. or there is no possibility of damaging these.

[0112] It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose head is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.

[0113] (3) Next, form a solder resist layer in the outermost layer of drum of the substrate in which optical waveguide was formed. The above-mentioned solder resist layer can be formed using the resin constituent used when forming the solder resist layer of for example, the above-mentioned substrate for IC chip mounting, and the same resin constituent.

[0114] (4) Next, form opening for solder bump formation, and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters. Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an

exposure development, the lasing, etc. In addition, formation of the above-mentioned opening for solder bump formation and formation of opening for optical paths may be performed simultaneously, and are independently good in a line. Moreover, in the process of above-mentioned (1) - (3), when the optical path which penetrates a substrate and a layer insulation layer is formed, opening for optical paths which was open for free passage to this opening is formed in a solder resist layer. Thus, by forming opening for optical paths which was open for free passage, this opening for optical paths becomes a part of optical path for lightwave signal transmission. After forming a solder resist layer, the optical path which penetrates a substrate, a layer insulation layer, and a solder resist layer may be formed at once.

[0115] In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development. It is because there is no possibility of attaching a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.

[0116] Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand if needed. By passing through an after process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand.

[0117] (5) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, tin, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out to the substrate for IC chip mounting using the approach of forming a solder pad, and the same approach.

[0118] (6) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad. In addition, PGA and BGA may be formed depending on the case. Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by arranging a pin in an external substrate connection side, or forming a solder ball in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand. By passing through such a process, the multilayer printed wiring board which constitutes the device for optical communication of this invention can be manufactured.

[0119] Next, how to manufacture the device for optical communication is explained using the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach. First, a solder connection is formed by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board, and both are connected electrically. That is, both are connected by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board to a position with the predetermined sense, respectively.

[0120] Moreover, in this process, even if some location gap exists among both when opposite arrangement of both is carried out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using both solder bump, both can be stationed to a position by the self-alignment effectiveness by solder at the time of a reflow.

[0121] Next, IC chip is mounted in the above-mentioned substrate for IC chip mounting, and it considers as the device for optical communication by performing a resin seal after that if needed. Mounting of the above-mentioned IC chip can be conventionally performed by the well-known approach. In addition, as mentioned above, as for IC chip, what can be mounted by flip chip bonding is desirable. Moreover, it is good also as a device for optical communication by connecting the substrate for IC chip mounting and multilayer printed wiring board which performed mounting of IC chip before connecting the substrate for IC chip mounting, and a multilayer printed wiring board, and mounted IC chip.

[0122]

[Example] Hereafter, this invention is further explained to a detail.

(Example 1)

A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for production A-1. layer insulation layers of the substrate for IC chip mounting, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight

section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicon system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for layer insulation layers was produced by making it dry for 10 minutes at 80-120 degrees C.

[0123] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for breakthrough restoration and a front face A-2. By 1.6 micrometers the diameter of grain of maximum size — SiO2 spherical particle (the Adtec Corp. make —) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.

[0124] A-3. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of the substrate for IC chip mounting was used as the start ingredient (refer to drawing 7 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed.

[0125] (2) Wash in cold water the substrate in which the circuit 24 was formed. a through hole 29 and a conductor — NaOH (10 g/l) after drying, and NaClO2 (40 g/l), Melanism processing the water solution containing Na3 PO4 (6 g/l) — melanism — it considers as a bath (oxidation bath) — and the conductor which performs reduction processing which makes a reduction bath NaOH (10 g/l) and the water solution containing NaBH4 (6 g/l), and includes a through hole 29 — the roughening sides 24a and 29a were formed in the front face of a circuit 24 (refer to drawing 7 (b)).

[0126] (3) the following approach after preparing the resin filler indicated to the above A-2 — after preparation — less than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24. That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 7 (c)).

[0127] (4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.

[0128] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which side-face 24a of a circuit 24 stuck firmly through the roughening side, and internal-surface 29a of a through hole 29 and the resin filler 30 stuck firmly through the roughening side was obtained (refer to drawing 7 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.

[0129] (5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, the land front face of a through hole 29, and a wall — a conductor — the roughening sides 24a and 29a were formed in all the front faces of a circuit 24 (refer to drawing 8 (a)). As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.

[0130] (6) Next, the somewhat larger resin film for layer insulation layers than the substrate produced by the above A-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the layer insulation layer 22 was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 8 (b)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for layer insulation layers was carried out for 30 minutes at 170 degrees C after that.
[0131] (7) Next, mind the mask with which the breakthrough with a thickness of 1.2mm was formed on the layer insulation layer 22, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the layer insulation layer 22 on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 8 (c)).
[0132] (8) The roughening side was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the layer insulation layer 22 (refer to drawing 8 (d)).
[0133] (9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the layer insulation layer 22 by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0134] (10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the non-electrolytic copper plating film 32 with a thickness of 0.6-3.0 micrometers was formed at the front face (the internal surface of the opening 26 for the Bahia halls is included) of the layer insulation layer 22, and the wall surface of a breakthrough 29 (refer to drawing 9 (a)).
[0135] [Nonelectrolytic plating water solution]
NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions] It is 40 minutes [0136] by whenever [30-degree C solution temperature]. (11) Next, stick a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 23 with a thickness of 20 micrometers was formed by exposing and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 9 (b)).
[0137] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 9 (c)).
[0138] [Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0139] (13) -- a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under the plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% -- the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 9 (d)). furthermore, the etching reagent used at the process of the above (5) and the same etching reagent (MEKKU dirty bond) -- using -- a conductor -- the roughening side was formed in circuit 25 (the Bahia hall 27 is included) front face.
[0140] (14) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make --) dissolved in the methyl ethyl ketone trade name: -- the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku -- formation

— shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 4.5 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 30min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).

[0141] (15) next, the layer insulation layer 22 and a conductor — the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 (the Bahia hall 27 is included) was formed, the condition for 30 minutes at 70 degrees C, and layer 34' of a solder REJISU constituent was formed in them (refer to drawing 10 (a)).

[0142] (16) Subsequently, stick the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical elements (a photo detector and light emitting device) was drawn in a solder resist layer, and they are 1000 mJ/cm2. It exposed by ultraviolet rays, the development was carried out with the DMTG solution, and opening with a diameter of 200 micrometers was formed. And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 35 for solder bump formation, and the opening 31 for optical elements, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed (refer to drawing 10 (b)). In addition, a commercial solder resist constituent can also be used as the above-mentioned solder resist constituent.

[0143] (17) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 35 for solder bump formation, and the opening 31 for optical elements. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36.

[0144] (18) Next, print soldering paste to the opening 35 for solder bump formation and the opening 31 for optical elements which were formed in the solder resist layer 34. Furthermore, by carrying out a reflow to the soldering paste printed to the opening 31 for optical elements at installation and 200 degrees C, performing alignment of light sensing portion 38a of a photo detector 38 and a light emitting device 39, and light-emitting part 39a While mounting the photo detector 38 and the light emitting device 39, the solder bump 37 was formed in the opening 35 for solder bump formation, and it considered as the substrate for IC chip mounting. In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs (refer to drawing 10 (c)).

[0145] B. The resin film for layer insulation layers was produced using the approach used by the production A-1 of the resin film for production B-1. layer insulation layers of a multilayer printed wiring board, and the same approach.

B-2. The resin constituent for breakthrough restoration was produced using the approach used by the preparation A-2 of the resin constituent for breakthrough restoration, and the same approach.

[0146] B-3. Copper clad laminate which 18-micrometer copper foil 8 laminates to both sides of the insulating substrate 1 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.6mm or BT resin of a multilayer printed wiring board was used as the start ingredient (refer to drawing 1111 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 1 — a conductor — the circuit 4 and the through hole 9 were formed.

[0147] (2) a through hole 29 and a conductor — the conductor which washes in cold water the substrate in which the circuit 24 was formed, and includes blasting and a through hole 9 for an etching reagent (the product made from MEKKU, MEKKU dirty bond) by the spray after drying — the roughening sides 4a and 9a were formed in the front face of a circuit 4 (refer to drawing 11 (b)).

[0148] (3) the following approach after preparing the resin filler indicated to the above B-2 — after preparation

— less than 24 hours — the conductor of one side of the inside of a through hole 9, and a substrate 1 — the circuit agenesis section and a conductor — the layer of resin filler 10' was formed in the rim section of a circuit 4. That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 10' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 11 (c)).

[0149] (4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 10' might remain neither in the front face of a circuit 4, nor the land front face of a through hole 9, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 10 was formed.

[0150] thus, a through hole 9 and a conductor — the surface section of the resin filler 10 formed in the circuit agenesis section, and a conductor — the front face of a circuit 4 — flattening — carrying out — the resin filler 10 and a conductor — the insulating substrate which side-face 4a of a circuit 4 stuck firmly through the roughening side, and internal-surface 9a of a through hole 9 and the resin filler 10 stuck firmly through the roughening side was obtained (refer to drawing 11 R> 1 (d)). this process — the front face of the resin filler layer 10, and a conductor — the front face of a circuit 4 turns into the same flat surface.

[0151] (5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 4, the land front face of a through hole 9, and a wall — a conductor — the roughening sides 4a and 9a were formed in all the front faces of a circuit 4 (refer to drawing 12 (a)). In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.

[0152] (6) Next, the somewhat larger resin film for layer insulation layers than the substrate produced by the above B-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the layer insulation layer 2 was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 12 (b)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for layer insulation layers was carried out for 30 minutes at 170 degrees C after that.

[0153] (7) Next, mind the mask with which the breakthrough with a thickness of 1.2mm was formed on the layer insulation layer 2, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 6 for the Bahia halls with a diameter of 80 micrometers was formed in the layer insulation layer 2 on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 12 (c)).

[0154] (8) Next, plasma treatment was performed using Japanese vacuum-technology company make and SV-4540, and the front face of the layer insulation layer 2 was roughened (refer to drawing 12 (d)). Here, argon gas was used as inert gas and plasma treatment was performed for 2 minutes on power 200W, 0.6Pa of gas pressure, and conditions with a temperature of 70 degrees C. Next, after exchanging internal argon gas using the same equipment, sputtering which targeted nickel was performed using SV-4540 the condition for [atmospheric-pressure / of 0.6Pa /, temperature / of 80 degrees C /, power 200W, and time amount] 5 minutes, and the metal layer which consists of nickel was formed in the front face of the layer insulation layer 2. In addition, the thickness of nickel layer is 0.1 micrometers.

[0155] (9) Next, the substrate in which nickel layer was formed into the non-electrolytic copper plating water solution of the following presentations was immersed, and the non-electrolytic copper plating film with a thickness of 0.6-3.0 micrometers was formed on nickel layer (refer to drawing 13 (a)). In addition, in drawing 13 , the layer which consists of a nickel layer and non-electrolytic copper plating film is indicated to be the thin film conductor layer 12.

[Nonelectrolytic plating water solution]

NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions] It is 40 minutes [0156] by whenever [30-degree C solution temperature]. (10) Next, stick a commercial photosensitive dry film on the substrate with which the thin film conductor layer 12 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 3 with a thickness of 20 micrometers was formed by exposing and carrying out a

development in a sodium-carbonate water solution 0.8% (refer to drawing 13 (b)).
[0157] (11) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 3 with a thickness of 20 micrometers was formed in the plating-resist 3 agenesis section (refer to drawing 13 (c)).
[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0158] (12) — a conductor with a thickness of 18 micrometers which carries out etching processing of the thin film conductor layer under the plating resist 3 with mixed liquor with a nitric acid, a sulfuric acid, and a hydrogen peroxide, carries out dissolution clearance and consists of a thin film conductor layer 12 and electrolytic copper plating film 13 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% — the circuit 5 (the Bahia hall 7 is included) was formed (refer to drawing 13 (d)).
[0159] (13) next, the thing for which the process of the process of above-mentioned (5) - (12) is repeated — the upper layer insulation layer and a conductor — laminating formation of the circuit was carried out (refer to drawing 14 (a) - drawing 15 (a)). furthermore, the approach used at the process of the above (5) and the same approach — using — the conductor of an outermost layer of drum — the roughening side was formed in the circuit.
[0160] (14) Next, the optical waveguide 18 which uses the following approaches for the position of the front face of the layer insulation layer 2 of an outermost layer of drum, and has the optical-path conversion mirror 19 was formed (refer to drawing 15 (b)). That is, beforehand, the optical waveguide (micro parts company make : 20 micrometers in width of face of 1mm, thickness) of the shape of a film which consists of PMMA by which the head formed 45-degree optical-path conversion mirror 19 in the end using the diamond saw which is 90 degrees of V types was stuck so that the side face of the other end by the side of optical conversion mirror agenesis and the side face of a layer insulation layer might gather. In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the layer insulation layer of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour. In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0161] (15) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 3.0 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. By adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C is prepared. Furthermore, the above-mentioned solder resist constituent was applied by the thickness of 35 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which optical waveguide 18 was formed, the condition for 30 minutes at 70 degrees C, and layer 14' of a solder REJISU constituent was formed in them (refer to drawing 15 (c)).
[0162] (16) Subsequently, make a solder resist layer stick the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical paths was drawn to one side of a substrate, and they are 1000 mJ/cm2. It exposed by ultraviolet rays, the development was carried out with the DMTG solution, and opening with a diameter of 200 micrometers was formed. And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 15 for solder bump formation, and the opening 11 for optical elements, and the solder resist layer 14 the thickness of whose is 20 micrometers was formed (refer to drawing 16 (a)).

[0163] (17) Next, the substrate in which the solder resist layer 14 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 15 for solder bump formation. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 16.
[0164] (18) Next, soldering paste was printed to the opening 15 for solder bump formation formed in the solder resist layer 14, and by carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 16 (b)).
[0165] C. IC chip was mounted in the substrate for IC chip mounting manufactured through manufacture **** of the device for IC mounting optical communication, and the process of Above A, the resin seal was performed after that, and IC mounting substrate was obtained. . Next, by making a position carry out opposite arrangement and carrying out a reflow of this IC chip mounting substrate and the multilayer printed wiring board manufactured through the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected, the solder connection was formed, and the device for IC mounting optical communication was manufactured (refer to drawing 1).
[0166] Thus, about the obtained device for IC mounting optical communication, an optical fiber is attached in an exposed surface from the multilayer printed wiring board of the optical waveguide which counters a photo detector. After attaching a detector in an exposed surface from the multilayer printed wiring board of the optical waveguide which counters a photo detector, The place which detected the lightwave signal with the detector after making a lightwave signal calculate with delivery and IC chip through an optical fiber, The desired lightwave signal could be detected and the device for IC mounting optical communication manufactured by this example became clear [having the engine performance which can be enough satisfied as a device for optical communication].
[0167] Suitably, form the optical path for lightwave signal transmission, and according to it moreover, except having changed the mounting position of a photo detector and a light emitting device, and the formation location of optical waveguide The device for IC mounting optical communication of the gestalt shown in drawing 2 -6 is manufactured using the same approach as an example 1. When the transmission ability of a lightwave signal was evaluated by the above-mentioned approach about this device for IC mounting optical communication, it became clear to have the engine performance which can be enough satisfied as a device for optical communication.
[0168]
[Effect of the Invention] Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position as described above, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 13] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 14] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 15] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 16] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Description of Notations]
100 Multilayer Printed Wiring Board
101 Substrate
102 Layer Insulation Layer
104 Conductor — Circuit
107 Bahia Hall
109 Through Hole
111 Opening for Optical Paths
114 Solder Resist Layer
118 Optical Waveguide
119 Mirror for Optical Conversion
120 Substrate for IC Chip Mounting

121 Substrate
122 Layer Insulation Layer
124 Conductor — Circuit
127 Bahia Hall
129 Through Hole
131 Opening for Optical Elements
134 Solder Resist Layer
138 Photo Detector
139 Light Emitting Device
140 IC Chip
141 143 Solder connection
142 Conductive Layer
150 Device for Optical Communication

[Translation done.]